



TECHNICAL MEMORANDUM

TO: Dennis Crumpler / OAQPS
FROM: Eric Boswell / NAREL
AUTHOR: Steve Taylor / NAREL
DATE: October 30, 2014
SUBJECT: Gravimetric Inter-Laboratory Comparison Study

Introduction

The EPA's National Analytical Radiation Environmental Laboratory (NAREL) conducts semi-annual gravimetric inter-laboratory comparison studies as part of its quality assurance support of EPA's Office of Air Quality Planning and Standards (OAQPS). The purpose of the gravimetric studies is to evaluate selected EPA and State laboratories that weigh Teflon® filters used for the determination of PM_{2.5} collected with Federal Reference Method (FRM) ambient air samplers. Five laboratories participated in this study. EPA's Region 4 laboratory located in Athens, GA provides pre- and post-weighing of filters for the PM_{2.5} Performance Evaluation Program (PEP). The EPA Region 2 laboratory located in Edison, NJ provides quality assurance oversight of laboratories in Region 2 that weigh filters for the PM_{2.5} program. EPA's Office of Air Quality Planning and Standards (OAQPS) laboratory, located in Research Triangle Park (RTP), NC, performs special studies and serves as a backup weighing facility for the PM_{2.5} PEP. The Puerto Rico Environmental Quality Board (PREQB) and the New Jersey Department of Environmental Protection (NJDEP) laboratories provide gravimetric analyses for their agency's air monitoring program. NAREL supplied the performance test (PT) samples and served as the reference laboratory for the study.

Mass determination of PM_{2.5} is performed using a microbalance to weigh the Teflon® collection filter before and after the sampling event. The amount of particulate matter (PM_{2.5}) captured onto the surface of the filter can be calculated by a simple subtraction of the filter tare mass or pre-mass from the sampled filter mass or post-mass. In order to accurately measure particulate mass at microgram levels, the microbalance must be located in a clean, dust free environmental chamber with precise temperature and humidity control. Elimination of static from Teflon® filter samples is also very important for accurate mass measurements.

Filters used in the study were 47-mm Teflon® filters manufactured by Measurement Technology Laboratory (MTL). MTL Inc. was awarded a contract in April 2010 to supply the nation's PM_{2.5}, PM₁₀, and low-volume lead (Pb) FRM networks with 47-mm Polytetrafluoroethylene (PTFE) filters. Historically, Whatman has supplied 47-mm Teflon® filters to the networks. The MTL filters use the same filter membrane material as Whatman; however, the support ring is made from polyfluoroalkoxy (PFA) which is over twice as dense as the polymethylpentene (PMP) support ring used by Whatman. As a result, the nominal filter mass of the MTL filter is 377-410 mg compared to the Whatman nominal mass of 146-150 mg. NAREL has replaced its 200-mg high side quality control check weight with a 500-mg weight in order to accommodate the larger mass range. Another noticeable difference between MTL and Whatman filters is the serial number location. MTL filters have the serial number printed on both sides of the membrane instead of on the filter support ring.

Samples for this study were created at NAREL using Met One Super SASS air samplers to collect various amounts of PM_{2.5} onto Teflon® filters. In addition to the loaded filter samples, blank filters and metallic weights were included as controls and to provide information concerning balance stability and calibration. This study compares captured mass determined by NAREL to captured mass determined by each of the participating laboratories.

Acceptance criteria for this type of comparison have not been established. There are PEP criteria established for laboratory and field blanks, and metallic standards. According to the PEP criteria, laboratory and field blanks should not vary by more than 0.015 mg and 0.030 mg respectively between pre- and post-measurements. Metallic standards should not vary by more than 0.003 mg. As an alternative to the PEP criteria, this study uses criteria based on actual mass data compiled from gravimetric PT studies administered by NAREL.

Experimental

Sample sets consisting of ten new MTL Teflon® filters and two metallic weights were assembled for each of the test laboratories. Each filter was carefully inspected using a light table to check for pinholes and fibers. The metallic weights were commercially available 100 and 500 milligram stainless steel weights that were slightly altered by clipping a small corner section from each weight. The samples were placed into individual labeled Petri-slides and equilibrated in NAREL's weighing chamber. Pre-mass measurements were performed before the samples were shipped by overnight mail to each test laboratory with instructions to pre-weigh the sample following their standard operating procedures for the determination of PM_{2.5} mass. As each test lab completed its pre-mass measurements and returned their samples to NAREL, the returned samples were equilibrated and weighed to determine NAREL's pre-mass of record. Results of this weighing session were compared to NAREL's first weighing session to determine if any significant changes in mass occurred while the samples were out of NAREL's custody. As an additional QA check, a third weighing session was also performed on a different day to verify NAREL's pre-mass results.

Three sampling events using three co-located Met One Super SASS air samplers were used to load seven filters from each sample set with PM_{2.5} mass. The remaining three filters from each set served as blanks. For all labs except Puerto Rico, the loading schedule for the filters is shown in table 1. Table 1 shows that each lab received two replicates of the 48-hour and 36-hour events and three replicates of the 24-hour event.

Table 1. Sampling Schedule for Gravimetric Filters

Filter_ID	Serial Number	Sample Start	Event Duration	Receiving Lab
T14-15333	T4529901	8/8/2014	48 hr	Region 2
T14-15334	T4529902	8/8/2014	48 hr	Region 2
T14-15335	T4529903	8/11/2014	36 hr	Region 2
T14-15336	T4529904	8/11/2014	36 hr	Region 2
T14-15337	T4529905	8/12/2014	24 hr	Region 2
T14-15338	T4529906	8/12/2014	24 hr	Region 2
T14-15339	T4529907	8/12/2014	24 hr	Region 2
T14-15340	T4529908	---	Blank	Region 2
T14-15341	T4529909	---	Blank	Region 2
T14-15342	T4529910	---	Blank	Region 2
T14-15343	T4529911	8/8/2014	48 hr	Region 4
T14-15344	T4529912	8/8/2014	48 hr	Region 4
T14-15345	T4529913	8/11/2014	36 hr	Region 4
T14-15346	T4529914	8/11/2014	36 hr	Region 4
T14-15347	T4529915	8/12/2014	24 hr	Region 4
T14-15348	T4529916	8/12/2014	24 hr	Region 4
T14-15349	T4529917	8/12/2014	24 hr	Region 4
T14-15350	T4529918	---	Blank	Region 4
T14-15351	T4529919	---	Blank	Region 4
T14-15352	T4529920	---	Blank	Region 4
T14-15353	T4529921	8/8/2014	48 hr	OAQPS

Filter_ID	Serial Number	Sample Start	Event Duration	Receiving Lab
T14-15354	T4529922	8/8/2014	48 hr	OAQPS
T14-15355	T4529923	8/11/2014	36 hr	OAQPS
T14-15356	T4529924	8/11/2014	36 hr	OAQPS
T14-15357	T4529925	8/12/2014	24 hr	OAQPS
T14-15358	T4529926	8/12/2014	24 hr	OAQPS
T14-15359	T4529927	8/12/2014	24 hr	OAQPS
T14-15360	T4529928	---	Blank	OAQPS
T14-15361	T4529929	---	Blank	OAQPS
T14-15362	T4529930	---	Blank	OAQPS
T14-15373	T4529941	8/8/2014	48 hr	New Jersey
T14-15374	T4529942	8/8/2014	48 hr	New Jersey
T14-15375	T4529943	8/11/2014	36 hr	New Jersey
T14-15376	T4529944	8/11/2014	36 hr	New Jersey
T14-15377	T4529945	8/12/2014	24 hr	New Jersey
T14-15378	T4529946	8/12/2014	24 hr	New Jersey
T14-15379	T4529947	8/12/2014	24 hr	New Jersey
T14-15380	T4529948	---	Blank	New Jersey
T14-15381	T4529949	---	Blank	New Jersey
T14-15382	T4529950	---	Blank	New Jersey

PREQB notified NAREL that problems with the temperature control of their weighing chamber would delay their pre-mass measurements and the subsequent return of their samples. Since the PREQB laboratory was unable to return their pre-weighed filters to NAREL in time to be included in the loading events shown in table 1, a separate filter loading schedule was necessary for PREQB. Three co-located Met One Super SASS air samplers were used to load seven of the filters designated for the PREQB lab as shown in table 2.

Table 2. Sampling Schedule for PREQB's Gravimetric Filters

Filter_ID	Serial Number	Sample Start	Event Duration	Receiving Lab
T14-15363	T4529931	8/19/2014	48 hr	PREQB
T14-15364	T4529932	8/19/2014	48 hr	PREQB
T14-15365	T4529933	8/19/2014	36 hr	PREQB
T14-15366	T4529934	8/19/2014	36 hr	PREQB
T14-15367	T4529935	8/19/2014	24 hr	PREQB
T14-15368	T4529936	8/19/2014	24 hr	PREQB
T14-15369	T4529937	8/19/2014	24 hr	PREQB
T14-15370	T4529938	---	Blank	PREQB
T14-15371	T4529939	---	Blank	PREQB
T14-15372	T4529940	---	Blank	PREQB

Following each collection event, samples were returned to NAREL's weighing chamber for equilibration. After allowing several days for filter stabilization and equilibration, the first post-mass measurements were determined for the loaded filters as well as the blank filters and metallic weights. A second post-mass measurement of all samples was performed after several more days to verify stability of the samples. The last weighing session before shipping the samples to the test labs became NAREL's post-mass of record. The filters and metallic weights were packed into small coolers with ice substitute and shipped back to the test labs for post-weighing.

Gravimetric Results

The calculated mass capture for each sample is shown in figure 1. The bars shown in figure 1 represent the mass capture determined by a test lab followed by NAREL's determination for the same loaded filter. Note: The PREQB filters were sampled on different days than the others.

Figure 1

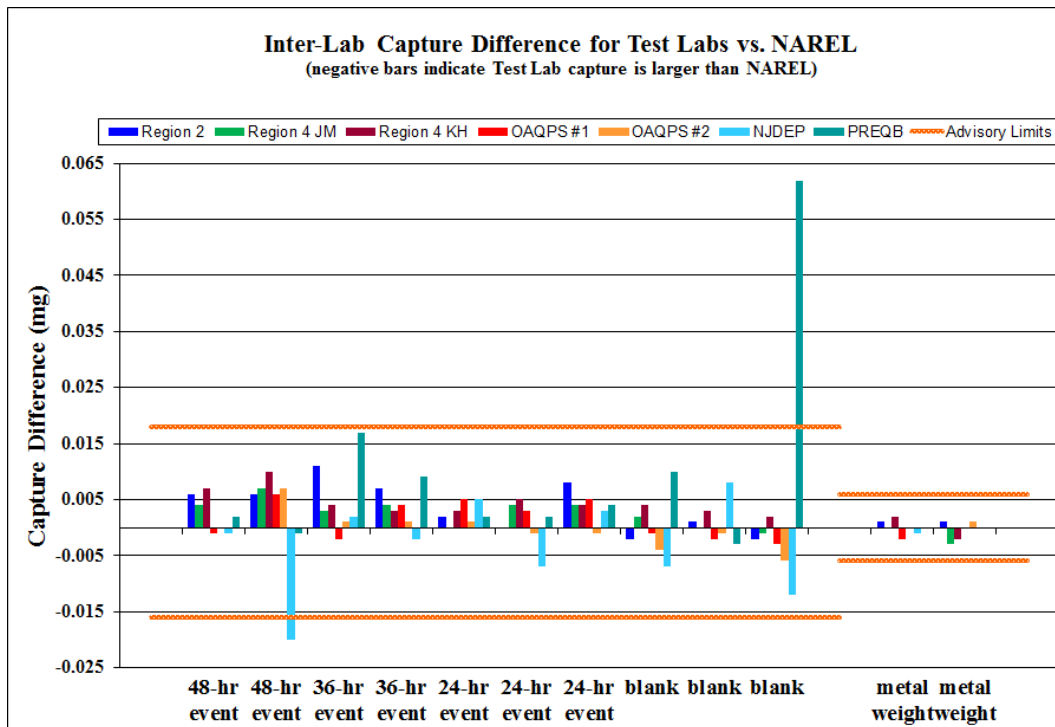
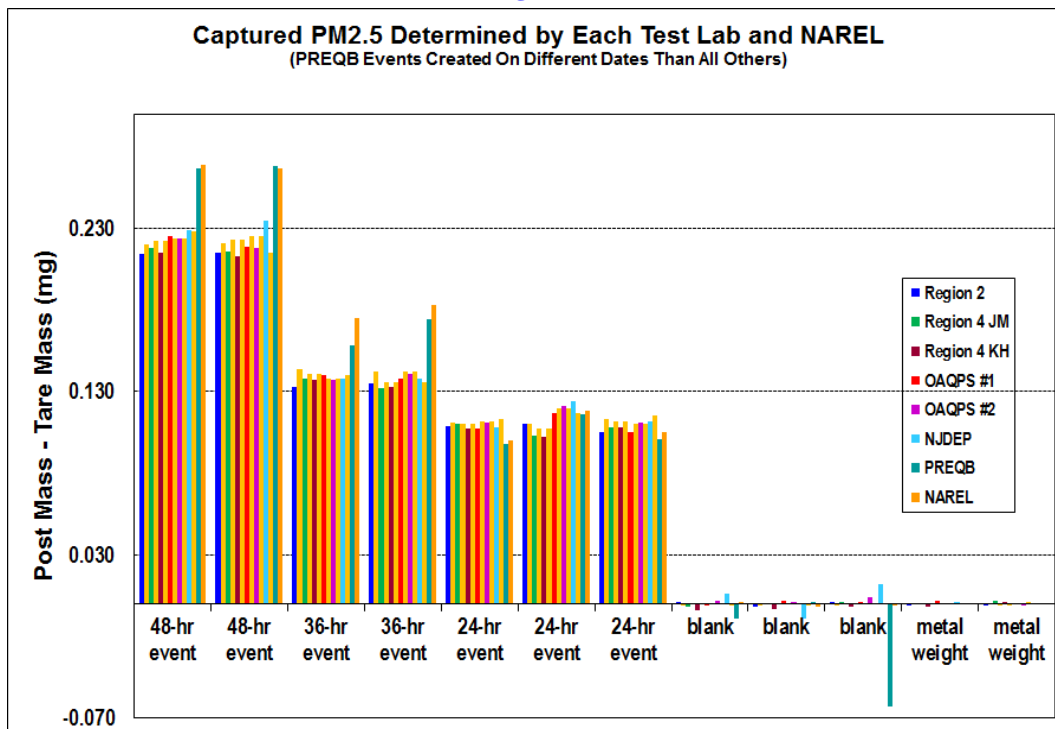


Figure 2

Figure 2 presents the inter-laboratory capture differences for all samples. Inter-laboratory differences were calculated by subtracting the capture value reported by the test laboratory from the capture value determined at NAREL. The advisory limits shown in figure 2 are 3-sigma limits derived from previous gravimetric PT studies administered by NAREL. The absence of a bar indicates perfect agreement between NAREL and the test lab.

Metallic weights were included in this study because they are less susceptible to weighing errors due to factors such as electrical static and volatility of filter constituents. This is indicated by the much tighter advisory limits for the weights. The same metallic weights were weighed at each laboratory during the initial tare sessions as well as during the final loaded sessions. The difference in initial and final mass is the calculated “mass capture” for the metallic weights. Ideally, the “mass capture” for the metallic weight samples would be zero. A large difference between an initial and final mass could indicate a balance stability or calibration problem.

The raw data used to calculate the mass capture and the inter-lab capture differences shown in figures 1 and 2 are presented in table 5 at the end of this report. The table includes the results of all filters and the metallic standards weighed at each laboratory. The table contains the filter pre-mass, the post-mass, and the calculated PM_{2.5} capture for each sample. Analysis of the data in table 5 is useful in determining where in the measurement process discrepancies in results between test labs and NAREL occurred. For example, figure 2 shows that one 48-hour event filter (T14-15374) and one blank filter (T14-15372) exceeded the advisory limits. Pre- and post-mass data extracted from table 5 is shown in table 3. For sample T14-15374, the data shows a 0.020 mg difference in the post-mass measurement was responsible for the advisory limit exceedance. For sample T14-15372, the disagreement between labs was with the pre-mass measurements.

Table 3.

Sample ID	Pre-Mass		Pre-Mass Difference	Post-Mass		Post-Mass Difference	Name of Test Lab	Sample Description
	Test Lab	NAREL		Test Lab	NAREL			
	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)		
T14-15374	370.755	370.755	0.000	370.990	370.970	.020	NJDEP	48-hr event
T14-15372	371.703	371.637	0.066	371.640	371.636	0.004	PREQB	Blank

For both of the above samples, NAREL has additional mass measurements determined before and after the samples were weighed by the test labs as shown in table 4.

Table 4

Filter_ID	Date of Measurement	Mass (mg)	Lab
T14-15372	07/11/2014	371.636	NAREL
T14-15372	8/18/2014*	371.703	PREQB
T14-15372	8/19/2014	371.637	NAREL
T14-15374	8/20/2014	370.970	NAREL
T14-15374	9/9/2014*	370.990	NJDEP
T14-15374	9/12/2014	370.970	NAREL
*Approximate date of measurement			

Conclusions

This inter-laboratory gravimetric study evaluated five federal and state laboratories that perform gravimetric measurements of PM_{2.5} collected on 47-mm Teflon® filters. The Teflon® filters used for this study were manufactured by Measurement Technology Laboratory (MTL). Samples for this study were created by loading Teflon® filters with PM_{2.5} collected from the ambient air using co-located Met One samplers. Blank filters and metallic weights were also included as samples. Each laboratory was allowed to pre-weigh and post-weigh a unique set of samples consisting of ten Teflon® filters and two metallic weights in order to determine the mass capture. NAREL served as the reference lab by weighing all samples. NAREL's pre-mass of record for each sample was determined shortly after each test lab had performed its pre-mass measurements. NAREL's post-mass of record was determined shortly before the sample sets were shipped back to the test labs for their final post-mass measurements. Performance was evaluated by comparing mass capture results determined by NAREL to mass capture results determined by each test laboratory. Performance criteria for this study is based on actual mass data compiled from all gravimetric PT studies administered by NAREL. Two samples out of 60 fell outside of the criteria, indicating overall good inter-laboratory agreement between the test laboratories and NAREL.

Table 5. Gravimetric Mass PT Results

Sample ID	Sample Description	Tare Mass		Loaded Mass		Captured PM _{2.5}		Inter-Lab Difference* of Captured PM _{2.5} (mg)	Name of the Test Lab
		Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)		
T14-15333	48-hr event	374.784	374.797	374.998	375.017	0.214	0.220	0.006	Region 2
T14-15334	48-hr event	372.057	372.071	372.272	372.292	0.215	0.221	0.006	Region 2
T14-15335	36-hr event	376.543	376.557	376.676	376.701	0.133	0.144	0.011	Region 2
T14-15336	36-hr event	373.384	373.399	373.519	373.541	0.135	0.142	0.007	Region 2
T14-15337	24-hr event	376.456	376.471	376.565	376.582	0.109	0.111	0.002	Region 2
T14-15338	24-hr event	375.378	375.394	375.488	375.504	0.110	0.110	0.000	Region 2
T14-15339	24-hr event	374.946	374.960	375.051	375.073	0.105	0.113	0.008	Region 2
T14-15340	blank	372.292	372.310	372.293	372.309	0.001	-0.001	-0.002	Region 2
T14-15341	blank	378.833	378.849	378.831	378.848	-0.002	-0.001	0.001	Region 2
T14-15342	blank	366.550	366.566	366.551	366.565	0.001	-0.001	-0.002	Region 2
MW14-15383	metal weight	495.538	495.544	495.537	495.544	-0.001	0.000	0.001	Region 2
MW14-15384	metal weight	84.753	84.756	84.752	84.756	-0.001	0.000	0.001	Region 2
T14-15343	48-hr event	370.639	370.634	370.857	370.856	0.218	0.222	0.004	Region 4 JM
T14-15344	48-hr event	368.677	368.672	368.893	368.895	0.216	0.223	0.007	Region 4 JM
T14-15345	36-hr event	366.171	366.167	366.309	366.308	0.138	0.141	0.003	Region 4 JM
T14-15346	36-hr event	367.904	367.898	368.036	368.034	0.132	0.136	0.004	Region 4 JM
T14-15347	24-hr event	379.742	379.737	379.852	379.847	0.110	0.110	0.000	Region 4 JM
T14-15348	24-hr event	374.058	374.051	374.161	374.158	0.103	0.107	0.004	Region 4 JM
T14-15349	24-hr event	372.320	372.312	372.428	372.424	0.108	0.112	0.004	Region 4 JM

Table 5. Gravimetric Mass PT Results

Sample ID	Sample Description	Tare Mass		Loaded Mass		Captured PM _{2.5}		Inter-Lab Difference* of Captured PM _{2.5} (mg)	Name of the Test Lab
		Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)		
T14-15350	blank	369.907	369.901	369.905	369.901	-0.002	0.000	0.002	Region 4 JM
T14-15351	blank	372.398	372.394	372.398	372.394	0.000	0.000	0.000	Region 4 JM
T14-15352	blank	370.289	370.284	370.290	370.284	0.001	0.000	-0.001	Region 4 JM
MW14-15385	metal weight	474.037	474.038	474.037	474.038	0.000	0.000	0.000	Region 4 JM
MW14-15386	metal weight	94.830	94.833	94.832	94.832	0.002	-0.001	-0.003	Region 4 JM
T14-15343	48-hr event	370.640	370.634	370.855	370.856	0.215	0.222	0.007	Region 4 KH
T14-15344	48-hr event	368.678	368.672	368.891	368.895	0.213	0.223	0.010	Region 4 KH
T14-15345	36-hr event	366.172	366.167	366.309	366.308	0.137	0.141	0.004	Region 4 KH
T14-15346	36-hr event	367.903	367.898	368.036	368.034	0.133	0.136	0.003	Region 4 KH
T14-15347	24-hr event	379.743	379.737	379.850	379.847	0.107	0.110	0.003	Region 4 KH
T14-15348	24-hr event	374.057	374.051	374.159	374.158	0.102	0.107	0.005	Region 4 KH
T14-15349	24-hr event	372.320	372.312	372.428	372.424	0.108	0.112	0.004	Region 4 KH
T14-15350	blank	369.908	369.901	369.904	369.901	-0.004	0.000	0.004	Region 4 KH
T14-15351	blank	372.400	372.394	372.397	372.394	-0.003	0.000	0.003	Region 4 KH
T14-15352	blank	370.288	370.284	370.286	370.284	-0.002	0.000	0.002	Region 4 KH
MW14-15385	metal weight	474.037	474.038	474.035	474.038	-0.002	0.000	0.002	Region 4 KH
MW14-15386	metal weight	94.831	94.833	94.832	94.832	0.001	-0.001	-0.002	Region 4 KH
T14-15353	48-hr event	378.524	378.518	378.749	378.742	0.225	0.224	-0.001	OAQPS Analyst 1
T14-15354	48-hr event	379.173	379.164	379.392	379.389	0.219	0.225	0.006	OAQPS Analyst 1

Table 5. Gravimetric Mass PT Results

Sample ID	Sample Description	Tare Mass		Loaded Mass		Captured PM _{2.5}		Inter-Lab Difference* of Captured PM _{2.5} (mg)	Name of the Test Lab
		Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)		
T14-15355	36-hr event	383.025	383.019	383.165	383.157	0.140	0.138	-0.002	OAQPS Analyst 1
T14-15356	36-hr event	378.486	378.480	378.624	378.622	0.138	0.142	0.004	OAQPS Analyst 1
T14-15357	24-hr event	384.188	384.180	384.295	384.292	0.107	0.112	0.005	OAQPS Analyst 1
T14-15358	24-hr event	375.162	375.154	375.279	375.274	0.117	0.120	0.003	OAQPS Analyst 1
T14-15359	24-hr event	369.348	369.339	369.453	369.449	0.105	0.110	0.005	OAQPS Analyst 1
T14-15360	blank	374.187	374.180	374.186	374.178	-0.001	-0.002	-0.001	OAQPS Analyst 1
T14-15361	blank	371.342	371.335	371.344	371.335	0.002	0.000	-0.002	OAQPS Analyst 1
T14-15362	blank	373.089	373.083	373.090	373.081	0.001	-0.002	-0.003	OAQPS Analyst 1
MW14-15387	metal weight	469.852	469.851	469.854	469.851	0.002	0.000	-0.002	OAQPS Analyst 1
MW14-15388	metal weight	99.714	99.714	99.714	99.714	0.000	0.000	0.000	OAQPS Analyst 1
T14-15353	48-hr event	378.523	378.518	378.747	378.742	0.224	0.224	0.000	OAQPS Analyst 2
T14-15354	48-hr event	379.173	379.164	379.391	379.389	0.218	0.225	0.007	OAQPS Analyst 2
T14-15355	36-hr event	383.024	383.019	383.161	383.157	0.137	0.138	0.001	OAQPS Analyst 2
T14-15356	36-hr event	378.484	378.480	378.625	378.622	0.141	0.142	0.001	OAQPS Analyst 2
T14-15357	24-hr event	384.185	384.180	384.296	384.292	0.111	0.112	0.001	OAQPS Analyst 2
T14-15358	24-hr event	375.159	375.154	375.280	375.274	0.121	0.120	-0.001	OAQPS Analyst 2
T14-15359	24-hr event	369.346	369.339	369.457	369.449	0.111	0.110	-0.001	OAQPS Analyst 2
T14-15360	blank	374.184	374.180	374.186	374.178	0.002	-0.002	-0.004	OAQPS Analyst 2
T14-15361	blank	371.34	371.335	371.341	371.335	0.001	0.000	-0.001	OAQPS Analyst 2

Table 5. Gravimetric Mass PT Results

Sample ID	Sample Description	Tare Mass		Loaded Mass		Captured PM _{2.5}		Inter-Lab Difference* of Captured PM _{2.5} (mg)	Name of the Test Lab
		Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)		
T14-15362	blank	373.086	373.083	373.090	373.081	0.004	-0.002	-0.006	OAQPS Analyst 2
MW14-15387	metal weight	469.854	469.851	469.854	469.851	0.000	0.000	0.000	OAQPS Analyst 2
MW14-15388	metal weight	99.713	99.714	99.712	99.714	-0.001	0.000	0.001	OAQPS Analyst 2
T14-15373	48-hr event	365.330	365.326	365.559	365.554	0.229	0.228	-0.001	NJDEP
T14-15374	48-hr event	370.755	370.755	370.990	370.970	0.235	0.215	-0.020	NJDEP
T14-15375	36-hr event	378.460	378.453	378.598	378.593	0.138	0.140	0.002	NJDEP
T14-15376	36-hr event	368.083	368.083	368.221	368.219	0.138	0.136	-0.002	NJDEP
T14-15377	24-hr event	369.770	369.766	369.878	369.879	0.108	0.113	0.005	NJDEP
T14-15378	24-hr event	372.553	372.553	372.677	372.670	0.124	0.117	-0.007	NJDEP
T14-15379	24-hr event	370.114	370.115	370.226	370.230	0.112	0.115	0.003	NJDEP
T14-15380	blank	369.650	369.651	369.656	369.650	0.006	-0.001	-0.007	NJDEP
T14-15381	blank	371.745	371.740	371.736	371.739	-0.009	-0.001	0.008	NJDEP
T14-15382	blank	372.093	372.093	372.105	372.093	0.012	0.000	-0.012	NJDEP
MW14-15391	metal weight	479.556	479.570	479.557	479.570	0.001	0.000	-0.001	NJDEP
MW14-15392	metal weight	96.350	96.353	96.350	96.353	0.000	0.000	0.000	NJDEP
T14-15363	36-hr event	372.286	372.267	372.444	372.442	0.158	0.175	0.017	Puerto Rico
T14-15364	36-hr event	374.306	374.295	374.480	374.478	0.174	0.183	0.009	Puerto Rico
T14-15365	48-hr event	371.953	371.941	372.220	372.21	0.267	0.269	0.002	Puerto Rico
T14-15366	48-hr event	370.410	370.408	370.678	370.675	0.268	0.267	-0.001	Puerto Rico

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Sample ID	Sample Description	Tare Mass		Loaded Mass		Captured PM _{2.5}		Inter-Lab Difference* of Captured PM _{2.5} (mg)	Name of the Test Lab
		Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)	Test Lab (mg)	NAREL (mg)		
T14-15367	24-hr event	369.677	369.673	369.775	369.773	0.098	0.100	0.002	Puerto Rico
T14-15368	24-hr event	371.495	371.492	371.611	371.61	0.116	0.118	0.002	Puerto Rico
T14-15369	24-hr event	370.244	370.239	370.345	370.344	0.101	0.105	0.004	Puerto Rico
T14-15370	blank	369.516	369.504	369.507	369.505	-0.009	0.001	0.010	Puerto Rico
T14-15371	blank	367.923	367.923	367.924	367.921	0.001	-0.002	-0.003	Puerto Rico
T14-15372	blank	371.703	371.637	371.640	371.636	-0.063	-0.001	0.062	Puerto Rico
MW14-15389	metal weight	484.902	484.902	484.902	484.902	0.000	0.000	0.000	Puerto Rico
MW14-15390	metal weight	87.548	87.550	87.548	87.55	0.000	0.000	0.000	Puerto Rico

** Negative values indicate a smaller capture determined by NAREL.*